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ART 84 ADOT

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by directing a jet of neutral gas entraining carbon against the surface of the melt at a supersonic velocity while oxygen for refining purposes is directed at the surface from separate and non-shrouding jets and the metal is bottom blown by neutral gas to prevent excessive foaming of the slag.

JP-A-61284512 discloses the production of high chrome steel by mixing chrome ore and coke powders in a blowing nozzle and blowing the mixture into the firing point of the molten iron both to melt and reduce the chrome ore.

GB-A-2 054 655, GB-A-2 122 649, and JP-A-58207313 relate to basic oxygen steel making processes in which molten metal is top-blown with oxygen and bottom blown with a different gas. Solids may be introduced with the gases.

JP-A-61106744A relates to the introduction of oxygen and solids into a furnace through tuyeres during the manufacture of stainless steel.

According to the present invention there is provided a method of refining a ferroalloy, including the step of blowing molecular oxygen or a gas mixture including molecular oxygen into a melt of the ferroalloy, wherein a metallurgically acceptable particulate material is introduced from above into the melt, the particulate material being carried into the melt in a first supersonic gas jet which travels to the melt shrouded by a second gas jet.

Preferably, only part of the molecular oxygen is supplied from below the surface of the melt in the method according to the invention.

By the term "ferroalloy" as used herein is meant an alloy which contains at least 10% by weight of iron. Typically, the ferroalloy contains at least 30% by weight of iron.

The metallurgically acceptable particulate material acts as a coolant and is preferably selected from metals that are to be included in the refined alloy, alloys of such metals, and oxides of such metals, and mixtures thereof.

performed, they would not penetrate the surface of the molten ferrochrome and would therefore have at most only a negligible reducing action. Analogous advantages can be achieved by employing as the metallurgically acceptable particulate material fine particulate charge chrome that is also obtained as a waste material in the production of the crude ferrochromium.

By introducing the metallurgically acceptable particulate material into the melt from above in a supersonic first gas jet, however, the momentum of the gas jet is such as to be able to penetrate both a slag layer on top of the surface of the molten ferroalloy being refined by the method according to the invention and the surface itself. By shrouding a first gas jet with the second jet, the rate of reduction in velocity that naturally occurs when a gas jet moves through a still atmosphere is not nearly so marked.

Preferably, the second gas jet is also a supersonic jet. More preferably, the first gas jet is ejected from a first Laval nozzle at a first supersonic velocity and the second gas jet is ejected from a second Laval nozzle at a second supersonic velocity, the second supersonic velocity preferably being from 10% less than the first supersonic velocity to 10% greater than the first supersonic velocity. Both the first supersonic velocity and the second supersonic velocity are preferably in the range of Mach 1.5 to Mach 4, more preferably in the range of Mach 2 to Mach 3.

Several advantages arise from the use of a supersonic second gas jet. First, the rate of decay of the first gas jet tends to less than when a subsonic first gas jet is employed. Accordingly, the first gas jet can be allowed to travel a greater distance before impinging upon the slag layer or the surface of the melt. The rate of damage to the Laval nozzles caused by the splashing metal or slag can thus be kept to an acceptable level. Secondly, the velocity of the second jet can be selected such that it too is able to penetrate the slag layer and the surface of the molten metal. Accordingly, any particles migrating from the first jet to the second jet are still largely carried into the molten metal. Thirdly, by forming the first and second jets at similar

CLAIMS

1. A method of refining a ferroalloy, including the step of blowing molecular oxygen or a gas mixture including molecular oxygen into a melt of the ferroalloy, wherein a metallurgically acceptable particulate material is introduced from above into the melt, the particulate material being carried into the melt in a first supersonic gas jet which travels to the melt shrouded by a second gas jet.
2. A method according to claim 1, wherein the metallurgically acceptable particulate material is selected from metals that are to be included in the refined alloy, alloys of said metals, and oxides of said metals, and mixtures thereof.
3. A method according to claim 1 or claim 2, wherein the ferroalloy contains at least 30% by weight of iron.
4. A method according to any one of the preceding claims, wherein the ferroalloy is ferrochrome and the metallurgically acceptable particulate material comprises an oxide of chromium.
5. A method according to claim 4, wherein the oxide of chromium is chromite.
6. A method according to any one of the preceding claims, wherein the metallurgically acceptable particulate material comprises ferrochrome.
7. A method according to any one of claims 1 to 3, wherein the ferroalloy is a stainless steel and the metallurgically acceptable particulate material is an oxide of chromium.

8. A method according to claim 1 or claim 2, wherein the ferroalloy is ferromanganese and the metallurgically acceptable particulate material is an oxide of manganese.
9. A method according to any one of the preceding claims, in which the metallurgically acceptable particulate material is introduced into the melt in fine particulate form.
10. A method according to claim 9, wherein the mean particle of the metallurgically acceptable particulate material is 1 mm or less.
11. A method according to any one of the preceding claims, in which the second gas jet is also a supersonic gas jet.
12. A method according to any one of the preceding claims, wherein the gas that forms the first gas jet is an oxidising gas, a non-oxidising gas, or a mixture of an oxidising gas and a non-oxidising gas.
13. A method according to claim 12, wherein the oxidising gas is oxygen.
14. A method according to claim 12 or claim 13, wherein the non-oxidising gas is one or both of argon and steam.
15. A method according to any one of the preceding claims, wherein the second gas jet is formed of burning gases.
16. A method according to any one of the preceding claims, in which the first gas jet is ejected from a first Laval nozzle at a velocity in the range of Mach 1.5 to Mach 4 and the second gas jet is ejected from a second Laval nozzle at a velocity also in the range of Mach 1.5 to Mach 4.

17. A method according to claim 16, wherein the first and second Laval nozzles form part of a metallurgical lance comprising an axial first gas passage terminating at its outlet and in the first Laval nozzle, a shrouding gas passage about the main gas passage terminating at its outlet end in the second Laval nozzle, and a particulate material transport passage having an axial outlet which communicates with the first Laval nozzle.
18. A method according to claim 17, wherein the said axial outlet terminates in the divergent part of the first Laval nozzle.
19. A method according to claim 17 or claim 18, wherein the shrouding gas passage comprises a combustion chamber.
20. A method according to any one of the preceding claims, wherein the metallurgically acceptable particulate material is introduced into the melt continuously during a first part of a refining operation.
21. A method according to claim 20, in which the first gas jet comprises oxygen and introduction of the first gas jet into the melt continues after introduction of the metallurgically acceptable particulate material into the melt has ceased.
22. A method according to claim 21, in which introduction of the first gas jet into the melt ceases before the end of the refining operation.